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Gas storage and transport properties of tight rocks: Impact of fluid-dynamics, rock mechanics and water saturation

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Summary

Gas storage and transport in unconventional, tight reservoirs are controlled by a variety of coupled physico-chemical processes. These are dynamically interlinked and may be of varying importance at different size and time-scales.

Our experimental work during the past two decades has been dedicated to the study of these processes under controlled laboratory conditions. We have developed a portfolio of experimental techniques that can be combined in a flexible way to determine the petrophysical and physico-chemical parameters of interest. The fluid transport studies comprise molecular diffusion, single-phase pressure-driven volume flow, non-Darcy flow phenomena (slip flow) and two-phase flow in low-permeable rocks. Steady-state procedures and different types of non-steady-state methods can be combined in order to determine transport parameters under various boundary conditions. These measurements are combined with the determination of adsorptive and volumetric gas storage capacity as a function of pressure, temperature and moisture content. More recently we extended our research to the analysis of variations in gas storage and transport parameters during loading and unloading of samples, which are interpreted in terms of poroelasticity.

In the past our group participated in several studies on the petrophysical characterisation of unconventional reservoir rocks. Thus, we were involved in the first European research project on gas shales, Gash, and provided petrophysical data for some of Europe's most important gas and oil shales. Furthermore, we conducted systematic measurements on single- and two-phase flow, gas breakthrough and relative permeability as a participant in Germany's major industry-funded tight gas project. Due to the increasing worldwide interest in oil shales we have started developing innovative procedures to assess the distribution and mobility of liquid hydrocarbons in the pore system of carbonaceous shales. Some recent publications emerged from these research efforts.

The Energy Transition politics in the EU and Germany have led to an increasing demand for research on subsurface storage of CO_2 and energy gases. While CO_2 storage and transport in sedimentary systems has been one of our recurrent research topics during the past 20 years, we have recently started experimental work on the storage and reactive transport of hydrogen (H_2).

In our contribution we will provide an overview of our experimental methods and approaches, the key information that can be derived therefrom.
Some of the topics that will be addressed are:

- Darcy and non-Darcy flow experiments with different gases
- Fluid-dynamic and rock-mechanical phenomena in tight rocks
- Influence of moisture (water saturation) on gas adsorption and gas permeability of shales and clays

While the demand for fossil fuel-related research in Europe, and particularly in Germany, is on the decline, we have established numerous contacts and co-operations on this field worldwide. In this context we particularly value the close and fruitful cooperation with our Canadian colleagues.